

Preparing Activity: LANTNAVFACENGCOM

UNIFIED FACILITIES GUIDE SPECIFICATIONS

Use for LANTNAVFACENGCOM projects only

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SECTION 02456N

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09/99

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SECTION 02456N

PRESTRESSED CONCRETE PILES

09/99

NOTE: This guide specification covers the
requirements for prestressed concrete piling.

NOTE: Suggestions for improvement of this
specification will be welcomed using the Navy
"Change Request Forms" subdirectory located in
SPECSINTACT in Jobs or Masters under
"Forms/Documents" directory or DD Form 1426.
Suggestions should be forwarded to:

Commander
Naval Facilities Engineering Command
Engineering Innovation and Criteria Office, Code EICO
1510 Gilbert Street
Norfolk, VA 23511-2699

Email: LantDiv@efdlant.navfac.navy.mil

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

NOTE: The following information shall be shown on the project drawings:

1. Location, size and cut-off elevation of project piles.
2. Location, size, cut-off elevation, and identification of test piles.
3. Subsurface soil data and boring logs where necessary.
4. Pile design load(s).

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

- | | |
|-----------|---|
| ACI 211.1 | (1991) Selecting Proportions for Normal, Heavyweight, and Mass Concrete |
| ACI 318M | (1992) Building Code Requirements for Reinforced Concrete (Metric) |
| ACI 318 | (1995) Building Code Requirements for Structural Concrete |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|-------------------|---|
| ASTM A 82 | (1995; Rev. A) Steel Wire, Plain, for Concrete Reinforcement |
| ASTM A 416/A 416M | (1996) Steel Strand, Uncoated Seven-Wire for Prestressed Concrete |

ASTM A 421	(1991) Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
ASTM C 150	(1997) Portland Cement
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 595M	(1997) Blended Hydraulic Cements (Metric)
ASTM C 595	(1994; Rev. A) Blended Hydraulic Cements
ASTM C 618	(1997) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 989	(1995) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 1143	(1981; R 1994) Piles Under Static Axial Compressive Load

PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI STD-112	(1984) Standard Prestressed Concrete Piles
PCI MNL-116	(1985) Quality Control for Plants and Production of Precast Prestressed Concrete Products

1.2 SUBMITTALS

NOTE: Where a "G" in submittal tags follows a submittal item, it indicates Government approval for that item. Add "G" in submittal tags following any added or existing submittal items deemed sufficiently critical, complex, or aesthetically significant to merit approval by the Government. Submittal items not designated with a "G" will be approved by the QC organization.

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-03 Product Data

Driving equipment, including driving helmets, cushion blocks and pile collars; G

Spudding and jetting equipment; G

SD-05 Design Data

Contractor mix design; G

[SD-06 Test Reports

NOTE: Delete these paragraphs for projects for which load testing is not specified. In paragraph entitled "Load Tests," insert the number of test piles to be load tested. Insert number of load tests in "Instructions to Bidders."

Load Tests; G

Test data and results as specified in Part 3.]

SD-07 Certificates

Driving hammer; G

Aggregate

Admixtures

Prestressing steel

Cement

Fly ash

Pozzolan

Ground Slag

Quality control procedures

SD-11 Closeout Submittals

[Test piles and] Job piles records; G

As specified in Part 3.

1.3 PILES

Provide prestressed pretensioned concrete piles designed in accordance with PCI STD-112. Production of piles shall be in accordance with PCI MNL-116. Piles shall be in one piece; splices will be permitted only when specifically authorized by the Contracting Officer.

1.4 LENGTHS AND NUMBERS OF PILES

NOTE: Insert values corresponding to total number of piles, total linear footage of piles, and tip to cut-off length of piles. Also delete reference to load tests when project does not contain load tests. Insert number of load tests in "Instructions to Bidders." When computing total linear footage of piles, use same tip to cut-off length for test piles as that used for job piles.

Base bids on providing [_____] piles, including test piles, totalling [_____] net linear meters feet (i.e., measurement includes cumulative

lengths of piles between tips and cut-off elevation only) and based on the estimated pile lengths of [_____] meters feet (tip to cutoff) for both standard job piles and test piles. Except when definite fixed lengths of piles are indicated, the Contracting Officer will determine the minimum depth of tip penetration and driving resistance required for job piles from the soil borings, from the characteristics of the driving equipment used, and from the results of test pile driving [and loading]. From these requirements, the Contractor shall prepare a schedule of the number of piles of each length to be used and their location. Submit schedule for approval before any piles, except test piles, are ordered. The Government reserves the right to take up to 3 working days to review test pile driving records and to take up to 3 additional working days to review and approve the Contractor prepared schedule of pile lengths and locations. The excess pile length ordered over the tip to cut-off length listed in the schedule as finally approved shall be the responsibility of the Contractor.

1.5 PAYMENT

The requirements of Contract Clause entitled "Variation in Estimated Quantity" shall not apply to payment for piling. Each pile and test pile acceptably provided will be paid for at the bid unit price per linear foot, which price shall include all items incidental to furnishing and driving the piles including jetting or pilot piles, redriving uplifted piles, and cutting off all piles at the cut-off elevation. Payment will be made at the bid unit price for the length of pile, from tip to final cut-off, actually provided, excluding build-ups and splices directed by the Contracting Officer to be made. Where the tip to cut-off length is less than that calculated from the results of test pile driving [and load testing], payment for that portion of pile not driven will be made at 75 percent of the bid unit price and no other payment will be made for making the cut-off. Payment for build-ups will be made at 125 percent of the bid unit price. Payment for splices, as specified, will be made at 25 times the unit price per foot bid for 10-inch piling, 22 times the unit price per foot bid for 12-inch piling, and 18 times the unit price per foot bid for all other piling. Should the actual cumulative pile length driven (tip to cutoff) vary more than 25 percent from the total pile length specified as a basis for bidding, at the direction of the Contracting Officer, the unit price per linear foot will be adjusted in accordance with the provisions of Contract Clause entitled "Differing Site Conditions." Piles required to be pulled at no fault of the Contractor will be paid for at the bid unit price for furnishing and driving pile in its original position plus 25 percent of this amount to cover the cost of pulling. Such pulled piles when redriven will be paid for at 25 percent of the bid unit price for the length driven. [Payment for each acceptably provided complete test loading of a single pile will be made at the contract unit price per test, which price shall include furnishing, placing, and removing testing equipment, and placing and removing test loads. At the direction of the Contracting Officer, load tests may be waived at a credit to the Government of the unit price bid therefor.]

1.6 EXCAVATION, SHEETING, DEWATERING, AND BACKFILLING

Provide under this section as specified in [Section 02315N, "Excavation and Fill."] [Section 02301N, "Earthwork for Structures and Pavements."]

1.7 QUALITY ASSURANCE

1.7.1 Mix Design

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolan, ground slag, and admixtures; and applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. An identical concrete mix design previously approved within the past 12 months by the Atlantic Division, Naval Facilities Engineering Command, may be used without further approval, if copies of the previous approval and fly ash and pozzolan test results are submitted. The approval of fly ash and pozzolan test results shall have been within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement.

1.7.2 Required Documents

Submit the precasting manufacturer's quality control procedures established in accordance with PCI MNL-116.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Contractor-Furnished Mix Design

ACI 211.1 or ACI 318M ACI 318. Concrete shall have a 28-day compressive strength of [35][_____] MPa [5000][_____] psi unless indicated or specified otherwise. Maximum aggregate size shall not exceed [25] [_____] mm [one] [_____] inch.

2.1.2 Concrete

Except as specified herein, concrete materials shall conform to Section 03300N, "Cast-in-Place Concrete."

2.1.3 Cement

NOTE: Insert type of cement required. Except where moderate or high sulfate resistance is required permit option for Type I, II, III, IP, or IS. For moderate sulfate resistance, specify Type II, III, IP(MS), or IS(MS) with a maximum tricalcium aluminate content of 8 percent. For high sulfate resistance, specify Type III or V, with a maximum tricalcium aluminate content of 5 percent.

ASTM C 150, [Type I, II or III] [_____] , or ASTM C 595M ASTM C 595, Type [IP(MS) or IS(MS)] [_____] blended cement except as modified herein. The blended cement shall consist of a mixture of ASTM C 150 cement and one of the following materials: ASTM C 618 pozzolan or fly ash, or ASTM C 989 ground iron blast-furnace slag. The pozzolan/fly ash content shall not exceed 25 percent by weight of the total cementitious material. The ground iron blast-furnace slag shall not exceed 50 percent by weight of total cementitious material. [Cement shall have a maximum tricalcium aluminate content of [5] [8] percent.]

2.1.4 Admixtures

ASTM C 494. Do not use admixtures containing chlorides.

2.1.5 Prestressing Steel

Prestressing steel shall be low relaxation strands or seven-wire stress-relieved strand conforming to ASTM A 416/A 416M or stress-relieved wire conforming to ASTM A 421, Type WA. The minimum ultimate strength shall be 1,720 MPa 250,000 pounds per square inch (psi). Prestressing steel shall be free from grease, oil, wax, paint, soil, dirt, loose rust, kinks, bends or other defects.

2.1.6 Ties and Spirals

Steel, ASTM A 82.

PART 3 EXECUTION

3.1 INSTALLATION

Inspect piles when delivered and when in the leads immediately before driving. Cut piles at cut-off grade with pneumatic tools, sawing, or other approved method. Where cut-off is below existing ground or mudline elevation, complete excavation, sheeting, dewatering, and backfilling before pile is driven to cut-off elevation.

3.1.1 Test Piles

NOTE: Insert the number of test piles required, the ordered pile length, and the tip to cut-off length.
The tip to cut-off length will be the same as that specified for job piles. The ordered pile length for test piles should be 1.5 m 5 feet longer than ordered length for job piles to allow additional penetration if driving conditions dictate. Test pile locations should be shown on the drawings. The number of test piles is normally between 5 and 10 percent of the total number of piles required, dependent upon the magnitude of the project.

Provide [_____] test piles conforming to the requirements for job piles. Order test piles [_____] meters feet in length. Provide tip to cut-off length of [_____] meters feet. The additional test pile length shall be driven only at the direction of the Contracting Officer. Record driving data as specified in paragraph entitled "Records." If approved after test completion, properly located test piles may be used in the finished work. Drive test piles in locations indicated or as directed.

[3.1.1.1 Load Tests

NOTE: Delete these paragraphs for projects for which load testing is not specified. In paragraph entitled "Load Tests," insert the number of test piles to be load tested. Insert number of load tests in "Instructions to Bidders."

Perform load tests on [_____] test piles in accordance with ASTM D 1143, as modified herein. Perform load tests at locations shown, or as directed. The load test will be conducted by the Contracting Officer. Provide facilities for the Contracting Officer to inspect and measure the deflection or settlement of the pile under test load. Furnish and set up test load equipment and load pile[s]. Load test equipment shall not be mobilized until directed. The safe design capacity of a test pile as determined from the results of load test shall be the lesser of the two values computed according to the following:

- a. One-half the test load which causes a settlement of 0.25mm 0.01 inch per ton of test load.
- b. One-half the test load that causes a gross settlement of 25 mm one inch provided the load-settlement curve shows no sign of failure.

13.1.2 Driving Piles

Drive at the hammer manufacturer's rated speed, and without interruption [to the [calculated] [indicated] tip elevation] [to reach a driving resistance and minimum depth of penetration in accordance with the schedule that the Government will prepare from the test pile driving data]. Drive piles with the same hammer, cushion, or cap block, and using the same operating conditions as test piles. If, in driving, it is found that any pile is not of a sufficient length to give the capacity specified, notify the Contracting Officer, who will determine which of the following procedures to follow:

- a. Drive an additional pile of the length directed adjacent to the first pile.
- b. Pull the first pile and drive a longer pile of the length directed.
- c. Drive the pile to an elevation below design cutoff and cast the concrete pile cap down to the level of the pile.

3.1.3 Driving Equipment

Pile hammer shall be air, steam, or diesel powered, and of an approved type with a capacity at least equal to the hammer manufacturer's recommendation for the total weight of pile and character of subsurface material to be encountered. The minimum driving energy for piles weighing less than 400 pounds per foot shall be not less than one foot-pound of energy per pound of pile; the hammer for heavier piles shall deliver not less than 30,000 foot-pounds of energy. Position a pile cap (often referred to as drive head or drive cap) or drive cap between the pile and hammer. Place hammer cushion between the ram and the pile cap. The hammer cushion shall have consistent elastic properties, shall minimize energy absorption, and shall transmit hammer energy uniformly and consistently during the entire driving period. A pile cushion, generally consisting of layers of hardwood or softwood boards or plywood, shall be placed between the top of the pile and the pile cap to distribute the blow evenly over the face of the pile and prevent pile damage. The pile cap shall fit loosely around the top of the pile so that the pile may rotate slightly without binding. The entire driving system shall be capable of protecting the head of the pile, minimize energy absorption and dissipation, and transmit hammer energy uniformly and consistently during the entire driving period. Driving system material types shall not be changed during pile driving operations."

3.1.4 Capacity

**NOTE: Insert quantity to reflect 100 percent of the
pile safe design capacity.**

Safe design capacity for piles is [_____] kN [_____] tons. The final driving requirements for job piles will be furnished to the Contractor by the Contracting Officer. The Government will use [load test and] test pile data, knowledge of soil characteristics, experience with existing soil conditions, and other empirical methods in determining the calculated pile tip elevation and the necessary driving resistance. Where piles are not required to be driven to practical refusal, or where the capacities of individual piles or pile groups are not required to be determined by loading test, the safe design capacity will normally be defined as a required maximum average penetration, in inches per blow, for the last 10 blows once the pile tip has achieved the minimum required tip penetration.

3.2 TOLERANCES IN DRIVING

At cut-off elevation, butts must be within [_____] [100] mm [4] inches of the location indicated. [Manipulation of piles will not be permitted.] [Manipulation to move piles into position will be permitted only within the aforementioned tolerance to return the pile to its design location.] [However, piles shall not be manipulated more than 1.5 percent of their exposed length above the [ground] [mudline] [surface].] A variation of not more than 2 percent from vertical for plumb piles or more than 4 percent from the required angle for batter piles will be permitted. [In addition to complying with the tolerances stated herein or otherwise specified, the clear distance between the heads of piles and the edges of caps shall be not less than 125 mm 5 inches. With prior approval of the Contracting Officer, the Contractor may provide additional concrete and reinforcement required to maintain the required minimum clear distance. Any redesign of pile caps or additional work required due to improper location of piles shall be approved by the Contracting Officer and shall be the responsibility of the Contractor.] Inspect piles for heave. Redrive heaved piles to the required tip elevation. Remove and replace with new piles those damaged, mislocated, or driven out of alignment, or provide additional piles, driven as directed.

3.3 JETTING OF PILES

**NOTE: Jetting should not generally be permitted in
instances 1, 2, 3, and 4, below. Predrilling should
not generally be permitted in instances a, b, and d,
below:**

1. Piles dependent on side friction in fine-grained, low- permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.
2. Piles subject to significant uplift.
3. Piles adjacent to existing structures.

4. Piles in closely spaced clusters unless the load capacity is confirmed by test and unless jetting and predrilling is completed before final driving of any pile in the cluster.

Water jets [will be permitted] [may be used in driving only when specifically authorized by the Contracting Officer] [shall not be permitted]. [Discontinue jetting when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration. Jetting method and equipment shall be approved by the Contracting Officer prior to commencing jetting operation.]

3.4 PREDRILLING

NOTE: Jetting should not generally be permitted in instances 1, 2, 3, and 4, below. Predrilling should not generally be permitted in instances a, b, and d, below:

1. Piles dependent on side friction in fine-grained, low- permeability soils (high clay or silt content) where considerable time is required for the soil to reconsolidate around the piles.
2. Piles subject to significant uplift.
3. Piles adjacent to existing structures.
4. Piles in closely spaced clusters unless the load capacity is confirmed by test and unless jetting and predrilling is completed before final driving of any pile in the cluster.

Predrilling to remove soil or other material representing the bulk of the volume of the pile to be driven [will be permitted] [will not be permitted] [shall be provided]. [Discontinue are drilling when the pile tip is approximately 1.5 m 5 feet above the [calculated] [indicated] pile tip elevation. Drive pile the final 1.5 m 5 feet of penetration.]

3.5 PROTECTION OF PILES

Take care to avoid damage to the piles during handling, placing the pile in the leads, and during the pile driving operations. Laterally support piles during driving, but do not unduly restrain from rotation in the leads. Swinging leads will not be permitted. [Where pile or projecting reinforcement orientation is essential, take precautionary measures to maintain the orientation during driving.] [Take special care in supporting battered piles to prevent excessive bending stresses in the pile.] Square the top of the pile to the longitudinal axis of the pile. If the Contractor elects to use a pile head with projecting strands or mild steel reinforcement, prevent direct impact forces from being transmitted through the reinforcement, by using a special driving head.

3.6 BUILD-UPS

If, in driving piles, the Contracting Officer determines that the pile length is insufficient so that the final elevation of the pile head is below the indicated cut-off elevation, the pile section may be extended to the required elevation by means of a cast-in-place reinforced concrete build-up in accordance with PCI STD-112. Details of means for protecting the joints by a suitable mortar or epoxy shall be submitted by the Contractor. In no case shall the length of the build-up exceed 1.8 m 6 feet.

Build-ups to be driven shall conform to PCI STD-112. Where build-ups are exposed to water, the Contractor shall protect the cast-in-place section from the water during its curing period. Buildups will not be permitted on more than 10 percent of the total number of piles. If this percent figure is exceeded, or if, in the judgment of the Contracting Officer, the clustered location of the build-ups is undesirable, piles of insufficient length shall be withdrawn and replaced with long piles. Concrete in build-ups shall have a minimum ultimate compressive strength of 35 MPa 5000 pounds per square inch.

3.7 RECORDS

Keep a complete and accurate record of each pile driven. Indicate the pile location, deviations from pile location, cross section shape and dimensions, original length, ground elevation, tip elevation, cut-off elevations, penetration in blows per meter foot for the entire length of penetration for test piles, penetration in blows per meter foot for the last

3.1 m 10 feet for job piles, hammer data, including rate of operation, make, and size, and any unusual pile behavior or circumstances experienced during driving such as redriving, heaving, weaving, obstructions, [jetting,] and unanticipated interruptions. A preprinted form for recording pile driving data is included at the end of this section. Submit complete and accurate records of installed piles to Contracting Officer within 15 calendar days after completion of the pile driving. Make pile driving records available to the Contracting Officer at the job site, no later than 24 hours after each day of pile driving.

-- End of Section --